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OPERATING EXPERIENCE SUMMARY

Office of Nuclear and Facility Safety

November 18 – December 1, 1999

Summary 99-47

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EVENTS

1. ULTRAVIOLET LIGHT EXPOSURE CAUSES EYE AND SKIN INJURY IN TWO CASES

On November 8, 1999, at the Lawrence Berkley Laboratory, two subcontractor electricians and two subcontractor plumbers received burns to the eyes while the electricians installed ultraviolet lighting fixtures in a newly constructed biology laboratory. The workers complained of painful and itchy eyes a day later and facility management sent the workers to the on-site medical facility for an examination. The workers were diagnosed with a temporary condition resulting from exposure to ultraviolet light. The results of a facility management critique are not yet available (ORPS Report No. OAK-LBL-OPERATIONS-1999-0004). A second similar event occurred on November 19, 1999, at the Oak Ridge National Laboratory, when three subcontractor machinists received eye and facial burns from an ultraviolet germicidal light while they reinstalled HEPA filters in a research laboratory laminar flow hood. One machinist reported to a local emergency room where he was treated for facial and eye burns and then released. When he continued to have facial and eye pain after the weekend, he returned to the on-site medical facility and was treated and released. The second machinist also reported to a local hospital for treatment of burns. The third machinist could not be reached for assessment. The results of a facility management critique are not yet available (ORPS Report No. ORO-ORNL-X10LIFESCI-1999-0003). Exposure to ultraviolet light can cause serious injury to the eyes and skin.

In the first event investigators determined that although the work order did not include a statement about the ultraviolet safety hazard, the light fixtures were clearly labeled with a hazard warning, which stated that power should be turned off before changing a lamp. They determined that after the electricians installed the light fixtures they kept them activated for 2 hours while they installed a safety interlock system designed to protect personnel from ultraviolet exposure. In the second event investigators determined that three Y-12 Facilities Maintenance machinists were reinstalling HEPA filters in a laminar flow hood that uses an embedded germicidal ultraviolet light to preserve living cultures. They also determined that the germicidal light is activated manually with a light switch when the hood is not being used and that the hood has a clearly visible warning label defining the ultraviolet hazard. Investigators determined that the machinists received a hazardous level of ultraviolet radiation when they removed the front panel of the hood to gain access to the HEPA filters and failed to turn off the switch to deactivate the germicidal light.

Figure 1-1. Ultraviolet Light Inside Laminar Flow Hood

EH engineers reviewed the ORPS database for other occurrences involving Ultraviolet (UV) light safety violations resulting in eye exposures and found two similar occurrence and numerous events of laser eye exposure. Although some of the events are related to Lasers, the potential eye damage is similar to UV and the same safety precautions should be employed as for lasers.

On September 29,1995, at LANL, a research student received acute mild UV burns to his eyes and facial skin. The student required emergency room treatment. The investigation determined that the student was not wearing the required safety glasses. (ORPS report ALO-LANL-1995-0007) In the second event on October 6, 1990, at Lawrence Livermore National Laboratory, a technician reported severe discomfort in both eyes from a plasma spray torch which emits high levels of UV. The worker was treated at a local hospital and released. The investigation determined that the worker was not wearing protective eyeglasses. (ORPS report OAK--LLNL-LLNL-1990-0022)

Weekly Summary 97-47 reported that operators at the Ames Laboratory left a Class IIIB laser operating unattended in violation of laboratory laser safety requirements. A laser safety officer who entered the room where the laser was operating reported that his eyes may have been exposed to the beam. A physician examined the safety officer's eyes and detected no damage. Investigators determined that the operator had not taken the mandatory laser and high-voltage safety training. They also determined that the operator should have performed the operation with the door closed, but he propped the door open for convenience. (ORPS Report CH--AMES-AMES-1997-0003)

Weekly Summary 96-48 reported that a security technician at Lawrence Livermore Site was hit in the eyes by the reflected beam from an operating Class IIIB laser when he entered a room to work on an interlock status panel. Investigators determined that a lead experimenter had left the laser on overnight, in violation of laboratory laser safety requirements. An ophthalmologist determined that there was no injury to the experimenter's eye. (ORPS Report SAN--LLNL-LLNL-1996-0060)

These occurrences highlight the need for stringent safety practices when working with UV. When personnel must work near energized UV light sources, extra precautions should be taken to avoid exposure. As illustrated in these events, the consequences of exposure may not be immediately apparent. Managers of facilities using lasers should ensure that experimenters use hazard controls appropriate for UV operations. Control measures include (1) engineering controls, such as interlocks; (2) administrative controls, such as lockout/tagout of light power sources, procedures, warning signs, labels, and training; and (3) personal protective equipment, such as eyewear, and special clothing.

The Hazard and Barrier Analysis Guide, developed by EH, discusses barriers that provide job-related hazard controls. The guide provides detailed guidelines for selecting optimum barriers, including a matrix that displays the relative effectiveness of various barriers in protecting against common hazards. A copy of the Hazards and Barrier Analysis Guide is available at http://tis.eh.doe.gov/web/oeaf/tools/hazbar.pdf or by contacting the ES&H Information Center, (800) 473-4375.

KEYWORDS: ultraviolet, exposure,

FUNCTIONAL AREAS: Industrial Safety

2. PRESSURE DIFFERENTIAL CAUSES TERTIARY-BUTYL ARSINE SPILL

On November 5, 1999, at the National Renewable Energy Laboratory, a researcher working with the Organometallic Vapor Phase Epitaxy system spilled a bubbler containing 100 cubic centimeters of a toxic and pyrophoric liquid known as tertiary-butyl arsine. Facility management evacuated the laboratory before the gas monitoring alarm sounded and alerted the emergency response team who stabilized the released chemical and collected it for disposal. There were no injuries and there was no fire associated with the spill. Chemical spills can cause fire and personal injury when handled incorrectly. (ORPS Report No. GO-NREL-NREL-1999-0002)

The Organometallic Vapor Phase Epitaxy system is a bench-top operation that uses tertiary-butyl arsine to produce samples of solar cells. Tertiary-butyl arsine liquid is highly flammable when exposed to air and either burns spontaneously or oxidizes forming an arsenic containing powder. Investigators determined that the bubbler installation instructions incorrectly stated that the bubbler was packaged at lower than local ambient pressure. Investigators also determined that the researcher followed the instructions correctly when he connected the bubbler to the Organometallic Vapor Phase Epitaxy system, and pressurized the system with nitrogen. Investigators discovered that the pressure differential across the system was insufficient to induce flow and the researcher perceived that there was a blockage. They also discovered that when the researcher could not determine the cause for the blockage he tried to relieve it by disconnecting a section of exhaust tubing leading to an effluent scrubber. Investigators determined that as a result of this action tertiary-butyl arsine liquid spilled into a ventilated equipment enclosure and a small quantity of the liquid spilled onto the floor outside of the enclosure. They also discovered that the researcher did not come into contact with the liquid and did not witness a flame or detect extreme heat.

KEYWORDS: tertiary-butyl arsine, pressure differential, pyrophoric

FUNCTIONAL AREAS: Materials Handling and Storage, Hazards Analysis

3. AMMONIA INHALATION CAUSES TWO CASES OF ILLNESS DURING WASTE TRANSFER OPERATIONS

On November 10, 1999, at the Hanford Site West Tank Farm, when a health physics technician inhaled ammonia vapor and became ill while he flushed a saltwell transfer line. The health physics manager escorted the technician to the Hanford Environmental Health Foundation for an examination and was later released with no injuries. The facility manager suspended work in the area and sent an industrial hygiene technician to investigate. (ORPS Report No. RP-LMHC-TANKFARM-1999-0013). A second event occurred on November 11, 1999, at the Hanford Site West Tank Farm, a health physics technician was overcome by ammonia vapor when he attempted to remove a plugged waste line jumper in a valve pit. The health physics manager escorted the technician to a first aid station for an examination and then to the Hanford Environmental Health Foundation for an extended evaluation. The facility manager suspended work in the area and sent an industrial hygiene technician to investigate the valve pit area and reinstall the pit cover. (ORPS Report No. RP-LMHC-TANKFARM-1999-0014). Waste transfer processes can release toxic ammonia vapor causing injury and illness.

In the first event, investigators determined that when the technician isolated the blockage and opened a valve to clear the waste line, he expected to see liquid flush water flowing from the pipe. They determined that there was an unexpected pressure increase in the waste line that caused a rapid discharge of radioactive waste, steam and ammonia vapor. Investigators determined that, in a waste transfer process, ammonia concentrations may be higher than expected and technicians must use caution when disconnecting waste lines. In the second event investigators determined that the technician accidentally inhaled the ammonia vapor normally exhausted through waste tank breather filters. They determined that in routine waste transfer operations, site procedures do not require the use of a respirator. Investigators determined that in the event of an ammonia release a health physics technician surveys the release area and establishes a barricade at a safe distance until the area is ventilated. EH will follow the investigation of these two incidents and report any significant developments.

EH has reported ammonia exposure events in a few other Summaries. Following are examples.

- OE Summary 96-12 reported that on March 15, 1996, approximately six pounds of ammonia were released to the atmosphere from the Kalina Test Facility at the Energy Technology Engineering Center. The release occurred when a plant electrician restored electrical power after a power outage and an automatic signal opened a motor operated valve. The electrician reported a strong smell of ammonia in the vicinity of the plant and notified security. Environmental personnel barricaded the area. When plant operators arrived, they closed the motor-operated valve and sealed the outlet of an open pipe. No injury or over exposure to personnel occurred. Failure to address the need for a lockout/tagout of the motor-operated valve resulted in a hazardous substance release to the atmosphere. (ORPS Report SAN--ETEC-KALINA-1996-0001)

- OE Summary 97-03 reported that on January 8, 1997, at the Fernald Environmental Management Project, a hazardous waste worker was loosening a bolt on a 110-gallon drum ring when the lid blew off, striking the ceiling 14 feet above the worker and coming to rest on the floor 3 feet away. The worker was exposed to ammonia fumes and became disoriented. The drums were being opened in a posted contamination area. The radiation work permit required anti-contamination clothing, but did not require respiratory protection. The facility manager suspended work in the area and ordered remaining personnel to leave the building. The worker complained of having a headache. She was taken to an off-site medical facility, where she was diagnosed with ammonia exposure. Pressurized drum lids can present several personnel hazards including: (1) possible injury from an expelled drum lid or burst drum; (2) exposure to radioactive or hazardous contents of the drum; or (3) exposure to pyrophoric materials, which can ignite and burn. (ORPS Report OH-FN-FDF-FEMP-197-0003)

KEYWORDS: ammonia vapor, inhalation

FUNCTIONAL AREAS: Industrial Safety

4. CONSTRUCTION WORKER PENETRATES CONDUIT CONTAINING ENERGIZED WIRING

On October 26, 1999, at Rocky Flats Environmental Technology Site, a construction worker accidentally drilled into a conduit that contained 120 Volt energized wiring on a horizontal structural brace while drilling holes to mount building supports. The worker, who was not wearing electrical safety gloves or shoes, did not receive an electrical shock. The facility manager immediately secured drilling operations, de-energized and locked out the circuit in the penetrated conduit. Although no personnel injury resulted in this event, construction incidents such as this have caused equipment losses, damage to services, injuries and even death. (ORPS Report RFO--KHLL-WSTMGTOPS-1999-0017)

Investigators determined that the worker could not see the electrical conduit during the drilling operation. They also determined that the worker stood on a stepladder to drill holes from underside of the horizontal brace, and the worker knew there was electrical conduit above the brace. However, he assumed the conduit was centered above the brace. The investigators determined that the worker did not look above the brace to verify the location of the conduit prior to drilling, and he did not drill any pilot holes to locate the conduit.

Investigators determined that the Job Hazard Analysis for the work package did not identify drilling and electrical hazards. They also determined that neither project managers nor the worker knew of any guidance or instructions for conducting the drilling operations. Investigators further determined that the construction manager did not conduct a walk-down of the work area before beginning work and that a lockout/tagout was not installed because other operations in the area had a higher priority.

Investigators determined that part of the corrective actions the facility manager has requested a detailed review of Job Hazard Analysis for the drilling operations for potential hazards not previously identified. The facility manager has also instructed personnel to review and revise the work package and work practices to identify locations of hazards while performing penetration work.
EH has reported similar occurrences in the Weekly Summary, where energized wiring was

penetrated by drilling operation. The following are some examples.

- OE Summery 99-29 reported that on July 7, 1999, at Los Alamos National Laboratory, a worker short-circuited electrical power in a room at the Tritium Facilities when he penetrated a metal switchbox and hit an energized 120-V ac wire with a mounting screw. The worker was installing wall units for modular furniture to a concrete block wall. The switchbox, which controlled room lighting, was located on the other side of the wall from the penetration location. The worker used a manufacturer-provided screw that was longer than the depth of the hole that had been predrilled according to the specifications of an approved penetration permit. The screw penetrated an existing ¼-inch diameter hole in the switchbox with which it was coincidentally aligned, chewed through the wire insulation, and caused a high-impedance short circuit. The wire and screw were burned in half. (ORPS Report ALO-LA-LANL-TRITFACILS-1999-0001)

- OE Summary 99-07 reported that, on February 9, 1999 at the Rocky Flats Environmental Technology Site, Telecommunications technicians drilled into two energized 120-Volt electrical lighting circuits while installing a telephone line in a trailer, causing two 20-amp circuit breakers to trip. Because there was no sparking, the technicians were unaware that they had drilled into the lines. However, workers inside the trailer noticed that the lights went out, assumed that the technicians caused the failure, and told them that they may have drilled into the trailer lighting circuits. The facility manager and a health and safety representative confirmed that no one was injured and directed the telecommunications technicians to stop work. Facility personnel locked out and tagged out the main power supply to the trailer and confirmed that the telecommunication technicians had drilled into the lighting circuits. Although no injuries resulted, failure to identify energized lines before drilling caused equipment damage and could have caused personnel injury or a fatality. (ORPS Report RFO--KHLL-779OPS-1999-0007)

These occurrences emphasize the importance of thorough pre-job planning, the use of lockout/tagout practices and the need for appropriate personnel protection equipment during construction activities involving energized electrical wiring. Line management should be responsible for detailed pre-job planning and work control activities. Supervisors should ensure that the workers follow work control processes and facilities procedures. Pre-job briefings, facility safety practices and proper training programs should identify the hazards associated with electrical and drilling activities. Continued communication with the front-line crew is line management's key to safe completion of operations.

Lessons Learned Report, Issue 98-02, Penetrating Hidden Utilities, includes lessons learned from events that involved cutting and drilling into utilities concealed behind walls, floors, and ceilings. It also provides recommendations for avoiding hidden utilities and includes useful references. Some of these recommendations include (1) physical verification and inspection, (2) use of approved personnel protective equipment, (3) marking location of utilities and (4) penetrate no deeper than required. Lessons Learned Reports are available at http://tis.eh.doe.gov/web/oeaf/lessons_learned/reports/.

DOE-STD-1120-98, *Integration of Environment, Safety and Health into Facility Disposition Activities*, provides guidance, for enhancing worker and public safety and environmental protection. The Standard promotes the application of principles of integrated safety management in DOE operations. These principles include (1) line management responsibility for safety, (2) well-defined roles and responsibilities, (3) skills commensurate

with responsibilities, (4) balanced priorities, (5) identified safety standards and requirements, (6) hazard controls specific to the operations in hand, and (7) work authorization.

KEYWORDS: work planning, work control, integrated safety management

FUNCTIONAL AREAS: Job Hazard Analysis, Electrical Safety

5. VENTILATION SYSTEM FIRE CAUSES LOSS OF CONTAMINATION CONTROL

On November 2, 1999, at the Oak Ridge East Tennessee Technological Park, British Nuclear Fuels Limited workers were cutting steel shells of compressor units with a plasma arc system in the Decontamination and Decommissioning Workshop when a fire started in pre-filters of a ventilation system. The fire spread to a High Efficiency Particulate Air filter battery resulting in the loss of air contamination control. The shift supervision shut off the ventilation unit, closed the dampers and evacuated personnel from the area. The site's fire department extinguished the smoldering filters and set a one-hour fire watch to ensure stable conditions. No personnel were injured and work was suspended in the area. A formal investigation was initiated to discover the cause of the fire and to recommend corrective actions. EH engineers will track the investigation and provide additional information when it becomes available. (ORPS Report ORO--BNFL-K33-1999-0008)

6. LEAKING WASTE VIOLATIONS AT FERNALD

On November 12,1999, DOE-Fernald received a Notice of Violation from the Ohio Environmental Protection Agency (OEPA), concerning two leaking mixed waste incidents. The notice is based on information reported by Fernald concerning two related incidents of mixed waste leaking from on-site storage containers. The OEPA determined that DOE-Fernald violated specific Ohio Administrative Code regulations and/or relevant OEPA Director's findings and orders governing on-site management of hazardous wastes. Leaking mixed waste can result in safety and health hazards to workers, fires and explosions, reactivity hazards, and corrosion of monitoring and process equipment. (ORPS Report OH-FN-FDN-FEMP-1999-0021)

The events cited in the notice are described below.

On July 7, 1999, a #306 container located inside Tension Structure 6 (TS-6) on the Plant 1 storage pad was identified as a Type 1 (leaking) container. Approximately 8 ounces of liquid had leaked onto the floor. The container leaked contaminated decant water, which was characterized as a RCRA waste due to the presence of perchlorethylene (41 mg/L) which is above the toxicity characteristic concentration of 0.7 mg/L. The bottom of the container was then wrapped with herculite and absorbent pads, and moved to Building 71 for repair. On October 7, 1999, the Waste Storage and Sampling group was notified that this same container had been identified as a RCRA container requiring liquid storage controls, and was thus being moved back to TS-6. The container had been delivered to and staged on the West side of Bldg. 71 but was never repaired. The container was discovered on October 7 and was no longer leaking. The container was observed to have

about 4 to 6 inches of remaining liquid. Liquid mixed waste from this container may have leaked into portions of the facility controlled storm drain system.

The second occurrence on July 19, 1999, was discovered during an inspection of TS-6. A second #306 container with the same material as the previous container was identified as a Type 1 (leaking) container, and approximately 6 ounces of fluid had leaked onto the ground. The container was transported to Building 71 for repair. The container was not able to be repaired the container at that time because the leak was at a seam; therefore, the container was placed over a trench drain with a contained sump in TS-6 until it could be moved to Bldg. 71. On September 30, 1999, this container was found to still be sitting over the sump. It had never been repaired, and all of the liquid appeared to have drained into the sump. Liquid mixed waste from this container may have leaked into sub-surface soils below the TS-6 trench drain and sump.

On October 14, 1999, Fernald site management self-reported these incidents to the Ohio EPA. On October 16, 1999, Fernald waste management operations initiated an internal non-conformance report to ensure the remaining liquid in the containers is properly repackaged and disposed. All similar liquid RCRA waste containers have been identified. The contents from these containers have been transferred to poly-lined 55-gallon drums or treated at the Advanced Wastewater Treatment facility. Movement of waste to the Plant 1 pad has been halted, pending completion of investigation and implementation of corrective actions to prevent recurrence.

Corrective actions were determined by waste management to include; (1) establishment of a long-term standing order to ensure supervisory personnel responsible for identifying Type I and II leaking containers are also responsible for tracking the repair or repack of the containers; (2) moving all plant 1 pad RCRA liquid containers into TS-6, or Building 79; (3) disposing or repacking any RCRA liquids now stored in metal box containers; and (4) updating procedures for handling leaking box-type containers.

Personnel responsible for hazardous wastes should review the Waste Management Act and ensure compliance with its requirements, including those set by States. Compliance with the Act is required by DOE O 5480.4, Environmental Protection, Safety, and Health Protection Standards. The Waste Management Act is mandated by 40 CFR, Rules and Standards Hazardous Waste, parts 260 through 265, 268, and 270. Failure to comply with state and local regulations may result in citations, violations, and fines. Managers at DOE facilities, who are responsible for operation, processing, storage of hazardous wastes should verify that procedures adequately address these requirements. Managers at DOE facilities should also ensure that work packages for transferring hazardous wastes address these requirements and that hazardous was determinations are performed when required. Following is a summary of some of the 40 CFR requirements that were cited in the Notice of Violation.

40 CFR 262.11 states that hazardous waste determinations must be completed for facilities that generate solid waste hazards. 40 CFR 264.174 states that, at least weekly, the owner or operator must inspect areas where containers are stored, looking for leaking containers and for deterioration of containers and the containment system caused by corrosion or other factors. 40 CFR 264.31 states that facilities must be designed, maintained, and operated to minimize the possibility of a fire, explosion or any unplanned sudden or non-sudden release of hazardous waste hazardous waste constituents to air, soil, or surface water which threaten human health or the environment 40 CFR 264.55

states that there must be at least one employee, either on the facility premises or on call, with the responsibility for coordinating all emergency response measures. The coordinator must be familiar with (1) all aspects of the contingency plan, (2) all operations and activities, (3) locations and characteristics of waste handled, (4) locations of all records, and (5) the facility layout. Also, the coordinator must have the authority to commit the resources needed to carry out the contingency plan.

KEYWORDS: environment, inspection, violations

FUNCTIONAL AREAS: Environmental Protection, Operations, Licensing/Compliance

7. FRONT-END LOADER RUPTURES A NATURAL GAS LINE CAUSING A FIRE

On November 11, 1999, at the Albuquerque Operations Office common grounds, a city of Albuquerque subcontractor operating a front-end loader, struck and ruptured an 8-inch natural gas distribution line. The gas ignited and caused an overhead 46Kv-power line to short to ground and started a small grass fire. The subcontractor immediately stopped work, shut down his equipment, and evacuated the work area. The Kirtland Fire Department responded, extinguishing the grass fire and isolated the gas line, allowing the remaining gas in the line to burn off. No injuries occurred and their was minimal damage to the front-end loader and powerline. Ruptures of active gas lines have the potential to cause injury, fatalities, equipment damage, or process interruptions.
(ORPS Report ALO-KO-SNL-NMFAC-1999-0015)

Investigators determined that the subcontractor was preparing the area to allow the installation of a city sewer line on DOE property. They determined that the gas line had been installed only two years earlier and was buried approximately 4 feet below the surface and DOE had clearly marked the route of the line with stakes and surface markings. The investigation determined that the contractor was excavating a pad for a heavy piece of equipment and inadvertently covered the markings for the gas line and dug where the line was buried. Investigators also determined that he had failed to follow a project manager's instruction marking the excavation boundaries and was working in an area that should not have been excavated. After the line was struck, DOE/ALO and the Kirtland Fire Department were notified and immediately directed that the isolation valves be closed. Emergency personnel went to the scene, established a perimeter around the area of the leak, and set up roadblocks to prevent access. Firefighters deployed with gas detection equipment and ordered a precautionary evacuation of the area.

EH has reported other gas line ruptures during excavation work in the Operating Summary. Some examples follow.

- OE Summary 99-08 reported that a construction subcontractor operating a track-hoe at the National Renewable Energy Laboratory struck and ruptured a 2-inch natural gas distribution line. The subcontractor immediately stopped work, shut down his equipment, and evacuated the work area. He had failed to follow a project manager's instructions as to the excavation boundaries and was working in an area that should have been excavated by hand. Although no injuries occurred and the gas did not ignite, ruptures of active gas lines have the potential to cause injury, fatalities, equipment damage, or process interruptions. (ORPS Report CH-NA-NREL-NREL-1999-0001)

- OE Summary 98-34 reported that a trenching machine operator struck and severed a 1-inch natural gas pipeline at the Los Alamos National Laboratory. Investigators determined that the construction contractor did not carry out the work in accordance with contract provisions because he did not maintain a red-line drawing at the work site that underground utilities relative to site benchmarks. Also, he did not direct workers to excavate by hand within 5 feet of utilities and did not consult site utility locator personnel before excavation began, as required by the activity hazard analysis. (ORPS Report ALO--LA-LANL-ADOADMIN-1998-0005)

- OE Summary 97-44 reported that a construction worker at the National Institute for Petroleum and Energy Research severed a 2.5-inch natural gas line with a trenching Machine, resulting in evacuation of the area. Investigators determined that the as-built drawings incorrectly identified the line depth. Investigators also learned that this was the third gas line ruptured during excavation activities that year. The other events included the following: (1) workers hit and ruptured a 1-inch natural gas line while excavating and (2) a contractor ruptured a 3-inch natural gas line while demolishing a building. Again, construction drawings did not show the correct location of the pipelines. (ORPS Report HQ--GOPE-NIPER-1997-0005)

Natural gas explosions can cause significant damage and loss of life. On December 11, 1998, in St. Cloud, Minnesota, workers attempting to lay a fiber optic cable cut a gas main, resulting in an explosion. The blast leveled three buildings, killed 4 people, and injured 10 others. Bureau of Labor Statistics data on construction-related occupational injuries show that in 1996, 50 fatalities were attributable to excavation work. Figure 7-1 shows a 1989 event at Lebanon, Missouri, in which an operator was killed when his road grader struck a10-inch propane pipeline.

Figure 7-1. 1989 Pipeline rupture and fire in Lebanon, Missouri

In most cases, trenching and excavation activities are performed by subcontractors, which makes it more important to have good communication and subcontractor control. If subcontractors are responsible for locating utilities before digging, they should demonstrate to facility management that underground utilities have been located, identified, and marked before excavation begins. Construction supervisors and project managers should review the following documents related to excavation activities.

OSHA 29 CFR 1926, Safety and Health Regulations for Construction, subparts 651(b) an 651(a)(3), make employers responsible for identifying underground hazards near a work area. 29 CFR 1926.965(c) requires that work must be conducted in a manner to avoid damage to underground facilities. Similarly, work must be performed in a manner that provides protection to the workers. DOE/EH-0541, Safety Notice 96-06, Underground Utilities Detection and Excavation, provides descriptions of excavation events, an overview of current technology for underground utility detection, specific recommendations for improving site utilities detection and excavation programs, and information on innovative practices at DOE facilities. It states that a central coordinator should not only assist in identifying underground utilities but should also record the findings. It can be obtained by contacting the ES&H Information Center, (800) 473-4375, or by writing to ES&H Information Center, U.S. Department of Energy, EH-72, 19901 Germantown Rd., Germantown, MD 20874. Safety notices are also available on the OEAF home page at http://tis.eh.doe.gov/oeaf/ll.html.

KEYWORDS: construction, excavation, gas line, underground, utility

FUNCTIONAL AREAS: Construction, Industrial Safety

8. TORCH CUTTING RESULTS IN CLOTHING FIRE

On November 11, 1999, at the Hanford Remedial Actions Projects, a subcontractor's anti-contamination rubber over boots caught fire during a pipe cutting task in a radiological controlled area. The worker extinguished the flames with his gloves and exited the control area. The worker was not injured and there was no spread of contamination. Radiological control technicians assisted the worker with the removal of his personnel protective equipment and the worker exited the control area with no contamination detected on his work clothing. His supervisor transported him to a health unit. Welding and cutting events have resulted in fires, personnel injuries, and fatalities. (ORPS Report RL--BHI-REMACT-1999-0007)

Investigators determined that the subcontractor was using a "Slice Torch" to cut pipe in a trench as part of a remedial action and he was wearing anti-contamination clothing, including a respirator. Investigators determined that the worker was wearing welding clothing covered by anti-contamination clothing. The investigators believe that the worker stepped on a hot piece of slag and his rubber anti-contamination overboot caught fire. The investigators determined that the anti-contamination clothing was fire retardant, but the latex overboots were not, and the fire scorched the back of the workers pants leg.

Some early lessons learned were developed from this event by facility management. The facility manager will present a discussion of this incident and the dangers of stepping on hot slag at the next pre-job brief. The management will require the use of leather firefighter boots be used when welding or hot cutting is performed even in contamination areas

EH has reported cutting and welding events in several Summaries. Following are some examples.

- OE Summary 99-28 reported that at the Allied Technology Group (ATG) Catalytics facility at Oak Ridge, contract welders cutting 1-in.-thick carbon-steel shielding caused a fire in a local-area process ventilation roughing filter constructed of pleated paper. They were cutting and shaping the shielding with an oxyacetylene torch 10 to 12 ft above floor level and approximately 3 ft from a ventilation duct when they saw flames in the filter. Facility personnel secured all ventilation fans to prevent the fire from spreading and all unnecessary personnel evacuated the building. An ATG shielding-installation supervisor attempted to extinguish the fire by injecting carbon dioxide into the ventilation duct, but this was unsuccessful. The supervisor eventually smothered the fire by removing a metal inspection plate upstream of the filter and injecting a dry chemical fire-extinguishing agent into the duct. There was no damage to the facility. The workers had unknowingly violated facility procedures that prohibited cutting, grinding, or welding within 35 ft of combustible material. (NRC Event Report Number 35914)

- OE Summary 97-45 reported that personnel at a commercial nuclear hot-cell facility reported a small fire in a flexible exhaust duct. Facility personnel believed the fire started when a piece of hot slag fell on the duct during the cutting of some steel plates being removed from a decommissioned hot cell. A fire watch extinguished the fire and was later hospitalized overnight for smoke inhalation. There was no

release of radioactivity to the environment and no damage to the facility. (NRC Event Number 33204)

- OE Summary 97-40 reported that a safety engineer at the Savannah River Site observed several safety violations by subcontract welders during two welding operations and stopped them. The violations included fire watch violations, failure to use proper protective equipment, and combustible materials in the immediate area. Corrective actions required the subcontract personnel to review (1) requirements for preparing a work site prior to welding, (2) requirements for fire extinguishers at the work site while welding, and (3) fire watch roles and responsibilities. (ORPS Report SR--WSRC-RMAT-1997-0009)

- OE Summary 97-11 reported that a welder at the Oak Ridge K-25 Site was fatally burned during a cutting activity when two layers of his anti-contamination clothing and coveralls caught fire, engulfing him in flames. All of the clothing was cotton. A DOE Type A accident investigation determined that sparks or molten metal (slag) from the cutting operation ignited his clothing. (Type A Accident Investigation Board Report on the February 13, 1997, Welding/Cutting Fatality at the K-33 Building, K-25 Site Oak Ridge, Tennessee, and ORPS Report ORO--LMES-K25GENLAN-1997-0001)

These events illustrate the potential dangers associated with welding, cutting, and grinding activities. These activities pose safety and health hazards to workers under any circumstances, but they pose unique hazards to facility personnel performing decontamination and decommissioning activities. Fire prevention is an important consideration for these operations. Open flames, electric arcs, hot slag, sparks, and metal spatter are ready sources of ignition. Sparks from cutting, particularly oxyfuel gas cutting, are generally more hazardous than those from welding because the sparks are more numerous and travel greater distances because they are propelled by the oxygen or air stream used in the cutting process. Isolation or protection of combustibles is essential, for they may be exposed to sparks that fall through holes, cracks, or other openings. If those sparks retain heat for a sufficient time, they might ignite combustibles.

Managers at DOE facilities undergoing deactivation need to ensure that vendors and subcontractors understand local work control practices and the importance of following safety requirements. Several publications provide guidance on welding and cutting safety and on reducing fire hazards. The following publications contain many general and specific recommendations and should be consulted by supervisors of welding and cutting operations.

DOE/EM-0142P, Decommissioning Handbook, March 1994, DOE Office of Environmental Restoration, provides requirements for worker protection during decontamination and decommissioning activities. It states that worker protection is an important element of any project. The handbook divides worker protection issues into three categories: (1) protection from radiation, (2) protection from toxic and hazardous materials, and (3) protection from traditional industrial safety hazards. It further states that DOE decommissioning activities may produce a combination of hazards not commonly encountered elsewhere (such as industrial safety hazards and radiological hazards) and lists OSHA regulations that apply to decommissioning, as well as key elements of a health and safety program. Section 12 of the handbook states that extra precautions are required for worker safety because hazards in the facility may be unknown and many activities are infrequently performed.

DOE/EH-0196, Bulletin 97-3, "Fire Prevention Measures for Cutting, Welding, and Related Activities," describes the fire protection measures necessary for those activities. Guidelines outlined in the bulletin include provisions for (1) management commitments, (2) job safety analysis, (3) permits, (4) isolation/protection of combustibles, (5) personnel protective equipment, (6) dedicated fire watches, (7) manual fire-fighting equipment, (8) emergency services, (9) site-specific hot work policies and procedures, and (10) information sharing.

29 CFR 1910.252, General Requirements, states that "cutting or welding shall be permitted only in areas that are or have been made fire safe." Section (a)(2)(vii) requires relocating combustible materials at least 35 ft from the work site. Where relocation is impracticable, combustibles shall be protected with flameproofed covers or otherwise shielded with metal or asbestos guards or curtains. Subpart I, Appendix B, "Non-mandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection," states that walk-downs of work areas should be performed to identify hazards before work begins.

The National Fire Protection Association (NFPA) publications Industrial Fire Hazards and Standard for Fire Prevention During Welding, Cutting, and Other Hotwork provide guidance for the removal and protection of combustibles during welding and cutting activities.

American National Standards Institute Standard Z49.1, Safety in Welding, Cutting and Allied Processes, covers all aspects of safety and health in the welding environment, emphasizing oxygen gas and arc welding processes. It contains information on protecting personnel and the general area, ventilation, fire prevention and protection, and confined spaces. Paragraph 6.2.2 requires a fire watch when combustible materials are closer than 35 ft to the point of operation. Paragraph 7.2.3 requires ducts used for local exhaust ventilation to be constructed of non-combustible materials and inspected to ensure proper function and to ensure that the internal surfaces are free of combustible residuals.

The following two welding and cutting safety publications, as well as many others, can be ordered from the American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126, by calling (800) 443-9353, or at http://www.aws.org: Fire Safety in Welding and Cutting outlines precautionary measures and safe practices to help avoid the hazards of fire and explosion; Safe Practices covers the basic elements of safety applicable to all welding, cutting, and related processes.

DOE/EH-0197, Safety Bulletin 97-3, can be obtained at http://tis.eh.doe.gov:80/docs/bull/links.html. OSHA regulations can be found at http://www.osha-slc.gov/OshStd_toc/OSHA_Std_toc.html. Industrial Fire Hazards and Standard for Fire Prevention During Welding, Cutting, and Other Hotwork, Standard 51B, can be obtained from the National Fire Protection Association, 1Batterymarch Park, P.O. Box 9101, Quincy, Massachusetts 02269-9101. NFPA codes and standards can also be ordered at http://www.nfpa.org or by calling the NFPA at (800) 344-3555.

KEYWORDS: decontamination and decommissioning, fire safety, industrial safety, welding, work planning

FUNCTIONAL AREAS: Decontamination and Decommissioning, Industrial Safety, Work Planning

9. CYLINDER REGULATOR FAILURE INJURES MECHANIC

On November 15, 1999, at Savannah River Site, an air-operated valve controlling process pipe draining mechanism was inoperable due to an electrical shut-down, which cut off power to the air compressor actuating the valve. The shift supervision temporarily provided a compressed-air cylinder as a source of energy for operating the valve. The cylinder regulator failed destructively as a mechanic was adjusting air pressure. The regulator pieces struck the mechanic in the abdomen, causing an abrasion. The mechanic immediately turned off the cylinder valve. The facility management secured the air cylinder. The mechanic was taken to the Savannah River Site Medical center, where he was treated for his injury and advised for a follow-up examination the next day. The worker wore safety glasses without side shields. Though the mechanic received superficial cut during this occurrence, there was a potential for more serious personnel injuries. (ORPS Report SR--WSRC-ERF-1999-0024)

Investigators learned that a lockout was established to permit the replacement of a cracked pipe joint in the process drain line, because 15 to 20 gallons of sludge were to be drained. This operation required opening of the air operated valve. They determined that the temporary air supply system to be used for manipulating the air-operated valve did not receive an engineering review before its use. The investigators determined that supervision did not check the rating of the pressure regulator. Investigators further determined that the work package did not include the use of the air cylinder and regulator that the line supervision did not establish the need for replacement of the defective pipe joint in a timely manner. This last minute decision resulted in lack of communication with other shutdown work in progress and prevented timely opening of drain control valve. Investigators also determined that maintenance engineers failed to analyze the hazards of temporary high-pressure source.

EH has reported similar events in the OE Summary, where work on pressurized systems where improper job hazard analysis or lack of communication with others posed potential danger to worker safety or caused injuries. The following are some examples.

- OE Summary 99-09 reported that at the Sandia National Laboratory Saturn Accelerator Facility, a worker was troubleshooting a problem with a low-impedance trigger assembly (or spider) when a bolt was expelled from the spider, hitting him in the forehead. The worker was removing bolts from a cover plate on the spider while the spider was still pressurized with an insulating gas. The ejected bolt bruised and cut his forehead. Before he began to work on the spider, the worker had locked and tagged out all electrical energy and gas pressure sources. However, he failed to relieve the residual gas pressure inside the spider. The maximum allowable working pressure of the spider is 90 psi. Investigators estimated the residual gas pressure was less than 20 psi. A co-worker applied first aid (cold compress) and took the injured worker to medical, where his cut was cleaned and sutured. Failure to verify the presence of stored energy resulted in injury to the worker. (ORPS Report ALO-KO-SNL-9000-1999-0001)

- OE Summary 98-27 reported that that workers deactivating a glove-box at Rocky Flats Environmental Technology Site found some pressurized air lines when they loosened fittings. The workers believed the lines were not pressurized because they had removed similar, but non-pressurized lines the previous day. In any case, the workers continued to open fittings even after they discovered the pressurized lines.

Investigators determined that the workers were not authorized to work on energized systems and that lockouts/tagouts had not been installed. (ORPS Report RFO--KHLL-771OPS-1998-0028)

These events illustrate the potential hazards to personnel who knowingly or unknowingly work on pressurized systems or isolated systems that contain stored energy. Workers need to verify that proper isolation boundaries have been established and stored energy relieved to a safe level before starting the work. Adequate communications with other work groups in the facility would have also prevented this occurrence.

DOE-STD-1030-96, *Guide to Good Practices for Lockouts and Tagouts*, section 4.2.3.3, states that systems, portions of systems, and components that operate at temperatures and pressures above ambient should be vented and, if necessary, drained or cooled. Section 4.5.1 states that potentially hazardous stored or residual energy must be relieved, disconnected, restrained, or otherwise rendered safe. If it is possible for stored energy to re-accumulate, a means should be provided for workers to verify that a safe level exists until they complete the work. This guidance is also repeated in DOE 5480.19, *Conduct of Operations Requirements for DOE Facilities*, chapter IX, "Lockouts and Tagouts," section 6.e, "Stored Energy."

The Hazard and Barrier Analysis Guide, developed by EH, discusses barriers that control the hazards associated with a job. The guide also provides a detailed analysis for selecting optimum barriers, including a matrix that displays the effectiveness of different barriers in protecting against some common hazards. A copy of the Guide is also available from the ES&H Information Center, (800) 473-4375 or at http://tis.eh.doe.gov:80/web/oeaf/tools/hazbar.pdf.

KEY WORDS: work planning, lockout, pressurized

FUNCTIONAL AREAS: Job Hazard Analysis, Communications

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